

ADMINISTRATIVE INFORMATION

1. **Project Name:** Multifunctional Metallic and Refractory Materials for Energy Efficient Handling of Molten Metals

2. **Lead Organization(s):**

West Virginia University
Department of Mechanical and
Aerospace Engineering
P.O. Box 6106
Morgantown, WV 26506-6106

Oak Ridge National Laboratory
Division of Materials Processing
P.O. Box 2008
One Bethel Valley Road
Oak Ridge, TN 37831-6083

University of Missouri-Rolla
Department of Ceramic Engineering
P.O. Box 314
Rolla, MO 65402

3. **Principal Investigator:** Ever J. Barbero, Professor and Chairman
Department of Mechanical and Aerospace Engineering
West Virginia University
(304) 293-3111 x2335
(304) 293-6689 (fax)
ebarbero@wvu.edu

4. **Project Partners:**

ILZRO
Frank Goodwin
fgoodwin@ilzro.org
(919) 361-4647 x 3018

Energy Industries of Ohio
Larry Boyd
boyd@energyohio.com
(216) 662-7044

SECAT, INC.
Subodh Das
skdas@secat.net
(859) 514-4989

WV Steel Futures, Inc.
George Psaros
(304) 723-4278

The Techs
James Anderson
janderson@thetechs.com
(412) 464-5000

Allied Minerals
Dana Goski
dgg@alliedmin.com
(614) 876-0244

AK Steel
Paul Janavicius
Paul_Janavicius@aksteel.com
(513) 425-2670

Teckcominco
Paul Kolisnyk
Paul.kolisnyk@teckcominco.com
(905) 822-2022 x234

Duraloy Technologies
Roman Pankiw
techmgr@duraloy.com
(724) 887-5100

Special Metals
Ram Iyengar
rivyengar@smcww.com
(304) 723-3701

Praxair Technologies
Michael Brennan
Michael_Brennan@praxair.com
(724) 598-1344

Metallux Systems
Mark Bright
mabright@metallux.com
(440) 349-8826

Monofrax Refractory
Amul Gupta
Amul_Gupta@cp.vesuvius.com
(716) 483-7270

MORCO Refractory
Mike Heying
mikeh@morco-inc.com
(636) 479-7770

Pechiney Rolled Products
Scott Goodrich
Scott.goodrich@pechiney.com
(304) 273-6707

Weirton Steel
Howard Snyder
howard.snyder@weirton.com
(304) 797-4999

Magneco/Metrel
Michael Anderson
mike@magneco-metrel.com
(630) 543-6660

Blasch
David Larsen
dlarsen@blaschceramics.com
(518) 436-1263

Sturm Rapid Response
Scottie Workman
scottie.workman@sulzerpumps.com
(304) 733-3229

Thermal Ceramics
Jason Street
jstreet@thermalceramics.com
(706) 796-4200

Unifrax
Gary Deren
gderen@unifrax.com
(716) 278-3821

Vesuvius McDaniel
Edward Dean
Ed.Dean@vesuvius.com
(724) 843-8300 x215

Emhart Glass
Steve Herrington
steve.herrington@emhartglass.com
(573) 437-2132 x220

Deloro Stellite
Jim Wu
jwu@stellite.com
(314) 983-0266 x15

Wheatland Tube Co.
J.A. Gruber
Jack.gruber@wheatland.com
(724) 346-7255

Kyanite Mining
Jesse Brown
jessebrown@kvanite.com
(434) 983-2085

California Steel Corp
Mike Syrko
msvrko@californiasteel.com
(909) 350-6300

5. **Date Project Initiated:** March 1, 2004

6. **Expected Completion Date:** February 28, 2007

PROJECT RATIONALE AND STRATEGY

7. **Project Objective:**

The project goal is to extend the molten metal containment and submerged hardware life by an order of magnitude and improve the thermal efficiency with energy savings of 333 trillion BTU/year and cost savings of approximately \$1 billion/year by 2020.

8. **Technical Barrier(s) Being Addressed:**

Containment of liquid metals during melting, recycling, and transfer processes in the aluminum, steel, and metal casting industries can lead to significant corrosion and wear or abrasion of the refractories in contact with the molten metal and slag. The corrosion and wear of the refractories result in contamination of the melt and failure of the refractory with energy loss through the containment walls and eventual attack of the container walls. The submerged hardware (sink and stabilizing rolls) are subject to aggressive attack in the molten bath. Subsequently, the submerged hardware requires its replacement in one to three weeks with significant loss of energy from down time and product quality during the change over process.

9. **Project Pathway:**

Due to the complex interaction between the various modes that are simultaneously occurring in the material processes involving molten metal usage, the project team has identified five major areas of emphasis which most efficiently lead to the achievement of the stated objective. These major pathways include (1) identification of mechanisms by which failure occurs in the hardware for each individual situation; (2) development of a comprehensive dynamic corrosion model for molten materials handling; (3) development of a thermal management scheme associated with the refractories used for molten metal material handling; (4) development of a systematic approach based on computational analysis and experimental data for design of materials and/or surface treatment/coating systems to enhance the life of molten metal containing and handling hardware by an order of magnitude and to improve the thermal management efficiency of the molten material containment materials; and (5) preparation of identified alloys, refractory, surface treatment/coating, and the determination of corrosion, wear, thermal properties, and mechanical properties under laboratory and production conditions.

10. **Critical Technical Metrics:**

The baseline metric for success or failure in this project is to significantly improve the thermal management in aluminum, steel, and metal casting industries and extend the service lives and performance of molten metal containment materials and submerged pot hardware through novel material design, fabrication, and implementation. The result of demonstrably extended service lives and more efficient insulation will be significant energy savings. Realization of the project objective of one order of magnitude service life extension will be achieved if the innovations resulting from the investigators' claims can be verified in both the laboratory and industrial level.

PROJECT PLANS AND PROGRESS

11. Past Accomplishments: N/A**12. Future Plans:**

- Survey and assessment of current industrial materials and processes relating to containment of molten metals and submerged pot hardware – Planned completion: 9/30/04
- Testing of current materials, consisting of lab scale, prototype scale, thermal conductivity, and post mortem analysis of various existing refractory and hardware materials – Planned completion: 9/30/05
- Dynamic corrosion model for hardware and refractory materials – Planned completion: 2/28/06
- Thermodynamic calculations for hardware and refractory materials – Planned completion: 2/28/06
- Identify new hardware and refractory materials – Planned completion: 9/30/05
- Test new hardware and refractory materials – Planned completion: 2/28/06
- Component testing of candidate materials – Planned completion: 1/30/07
- Energy assessment of new components implemented at various industrial sites – Planned completion: 2/28/07
- Synthesis of all data – Planned completion: 2/28/07

13. Project Changes: None to date**14. Commercialization Potential, Plans, and Activities:**

This project is unique in the sense that there is a technology pull from industry, as opposed to a technology push from academia and research organizations. The willingness of the project partners to fabricate and test the investigators findings is vital to the achievement of the stated project objectives. This cooperative effort will be of mutual benefit to industry and academia by enabling the investigators to focus on advancements that can be brought to the commercial market. Since the primary focus of this project is to improve existing components of established aluminum, steel, and metal casting processes, the benefits to the manufacturers can be easily implemented. It is anticipated that the participating companies, users, and producers will not have to pay any licensing from inventions resulting from this effort.

15. Patents, Publications, Presentations: None to date